Inter-organizational collaboration, information flows, and the use of social media during disasters: a focus on vulnerable communities

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Abstract

This study contributes to ongoing attempts by scholars to understand the many ways that social media is being used by disaster and crisis response actors. We present a case study consisting of emergency response organizations, government agencies, local government, non-government organizations, community groups and platform-based actors, and focus specifically on how social media is used in this context to support the information needs of vulnerable groups. We examine how tension between the presence of top-down, generic information and the need for contextualized and specific information is resolved, and the translation processes that occur between the range of actors. We also offer recommendations for future research to address the disproportionate impacts of disasters and crises on vulnerable groups.

1. Introduction

In recent years, there has been growing interest in the field of research known as 'crisis informatics' [1, 2]. This field combines social science and computing knowledge to better understand how organizations and people use digital technology to respond to disasters and crises [3], such as wildfires, hurricanes, and earthquakes. Within the crisis informatics research we draw on and contribute to two streams. The first focuses on how technology can improve inter-organizational collaboration, information sharing and other operational areas of response efforts [4, 5]. Studies in this stream examine emergency response organizations (EROs) such as police and fire, government agencies, non-government organizations (NGOs) and community and volunteer groups. Recent research in this stream demonstrates how digital technology—in particular social media[1]—is resulting in porous boundaries between these organizations, challenging the bureaucratic and top-down logic of coordination and information sharing [6-8]. With few exceptions [8], little research has sought to understand the evolving information landscape of actors such as EROs and government agencies (who we refer to as 'upstream' actors) and informal organizations such as NGOs, community groups, local social media networks and private/platform-based organizations (who we refer to as 'downstream' actors)[2], as they seek to access and provide information to each other and their constituents. The second stream of research focuses on how social media is used by individuals and how crowdsourced data is used to inform decision making and enhance situational awareness of EROs and government agencies [1, 8, 9]. While this research has grown significantly, it has neglected the interplay of social media and the evolving landscape of organizations; in particular, how downstream actors use social media to interpret, translate and contextualize top-down information as well as to provide information to specific audiences.

We bring these two streams of research together to examine how the range of organizations use social media to address the concerns of vulnerable persons—defined broadly as a group or community whose circumstances create challenges to obtaining, understanding or seeking information, or to their ability to respond in the same way as the general population [10]. This framing typically encompasses older, disabled, lower socio-economic, isolated and marginalized persons [11]. While these groups are sidelined in the crisis informatics literature, reports and studies demonstrate that they suffer disproportionately from disasters and crises [12, 13].

[1] By social media we refer to Web 2.0 platforms/mobile apps that allow for the creation and sharing of user-generated content.

[2] Upstream and downstream refers to position in the information hierarch; whereby information is distributed from the EROs and government agencies (upstream) for action, interpretation and contextualization by actors downstream.

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A focus on vulnerable persons is important given the frequent pattern of information provision during a disaster: typically, upstream actors such as EROs and government agencies provide warnings and information to the public (the top-down logic), information that tends to be generic. This is in tension with the often specific information needs and technology practices of vulnerable persons [7]. We examine how this tension is resolved by community groups and NGOs—using social media and other means—to provide contextualized content and reach out to vulnerable groups. Scholars have called for research to focus on the specific information needs vulnerable groups as well as how they use social media [7].

We address the research question: *In the context of disasters and crises, how do actors use social media to provide information to vulnerable persons*? To address this question, we undertake a qualitative case study consisting of 28 organizations. Our sample includes actors across the spectrum—including upstream and downstream response and service/information providers involved in the disaster preparation, mitigation, response and recovery phases.

We demonstrate how the organizational actors adapt generic disaster information and contextualize it for vulnerable persons, and the different social media strategies used for doing so. At the same time, we identify tensions between consistent and reliable information, the need for specificity, and the role of technology; by doing so we render this tension more visible to theorizing. In adding to the literature on disaster and crisis response actors [6, 14] we highlight the need to take more seriously how this kaleidoscopic network can better support the needs of vulnerable persons. To address the needs of vulnerable persons and develop resilient communities it is necessary, we argue, to capture and grasp complex interactions between the different stakeholders.

In what follows, we first consider the relevant research and focus on three themes that inform our study (Section 2). In Section 3 we describe the setting of our study and the methods used to collect and analyze our data. Section 4 presents our findings. Section 5 outlines the key theoretical contributions and directions for future research.

2. Relevant work

From our review of the literature, three major themes inform our study. The first theme deals with the network of actors in disaster and crisis response. The second covers work related to information challenges and the mediating role of digital technology. The third relates to addressing the needs of vulnerable populations. In the following sub-sections, we examine the contributions of each theme.

2.1 Multilayered and converging actors

Responding to complex, high-velocity, unpredictable, and time-critical incidents requires rapid and simultaneous intervention from different organizations [14-16]. The possible arrangement of organizations, structures, and divisions of tasks are traditionally framed as four archetypes [17]. The first are 'established' organizations, such as the EROs, that undertake tasks (e.g. manage fires, close roads), or other government agencies involved in managing a disaster or crisis as part of their core responsibility (e.g. a government department of health or a central emergency organization). These organizations are at the apex of a bureaucratic or top-down structure [7]. Second are 'expanding' organizations, which consist of a small standing organization and a larger group of trained staff/volunteers that can be mobilized. These organizations, such as the Red Cross, can expand and retract as needed. Third are 'extending' organizations that perform tasks outside of their traditional role (e.g. organizations that supply food, shelter and logistical support). Fourth are 'emergent' groups, such as community groups and volunteers that often have fluid memberships that perform non-regular tasks [15]. While established organizations are often the lead agency during disaster and crisis, the other levels are more dynamic and fill the gaps left by the established organizations. In the structure described, information is distributed from the established actors (i.e. upstream actors) for action, interpretation and contextualization by downstream actors.

Studies have built on the four-level conceptualization of organizational types by demonstrating how organizations form clusters to collectively coordinate efforts to handle unfolding disaster events [14] or how digital technology breaks down boundaries between organizations and activities [6]. For instance, the Red Cross created the Ready2Help platform that matched individuals needing help with people who could offer it [6]; other examples include crowdsourcing and mapping platforms that guide relief efforts. Citizens, volunteers and community groups are also leveraging digital technologies—social media in particular—to address emergent demands and fill localized information and support needs [18]. These emergent digital networks typically form when a crisis presents itself and may develop into stable organizations (e.g.

local groups connected by social media). These shifts suggest the convergence of organizational boundaries and activities as well as the convergence of physical and online spaces [6, 8]. While this presents new opportunities, it also raises challenges for providing effective support, and consistent and relevant information. As the number of actors grows, the priorities of these actors will overlap: across time (e.g. the preparedness, mitigation, response and recovery phases); across space in terms of the spatial dimension of a disaster; across different stakeholder groups; and across information management capabilities in terms of acquisition, processing and content, sources and dissemination. As the interactions and relationships between organizations, individuals and technology move away from the bureaucratic, top-down logic, they become more complex and may result in behavior that is difficult to predict [7].

2.2 Information and digital technology

Disasters and crises are characterized by several types of information challenge that complicate the responses of organizations and individuals. For instance, the most appropriate channels for distributing and sharing information, its format and content, and the volume, veracity and timing of information [2]. Evidence clearly suggests that the quality of information sharing and communication can reduce the risk from disasters and support recovery [2, 19] and that many disaster related deaths may have been saved '*with better information and communication*' [20]. For instance, an investigation into heat waves in France concluded that access to basic information, such as advice to wrap yourself in damp cloths or drink enough cold water, could have reduced the death toll amongst the elderly [11]. As well as saving lives, information reduces suffering in the recovery phase by helping victims to trace lost family and friends, to find out what aid they are entitled to and where to seek shelter [20]. A challenge that remains is a lack of understanding on how to frame information [21]; specifically, how information and warnings are best provided and the ability of humans to interpret information on low-probability and high-intensity incidents. For instance, studies have argued that warnings such as 'Do Not Panic', 'Amber Alert' or 'Stay/Go' are confusing and do not inform citizens whether they should be alarmed or what action they should take [19, 21]. Therefore, citizens are faced with the challenges of sensemaking and assessing information accuracy under dangerous conditions [22]. Increasing the volume of warnings also raises the possibility of information overload, resulting in citizens neglecting critical information or it triggering inappropriate and counterproductive responses. This critically includes, but is not limited to, delaying responses [21] or overreacting and responding to misinformation [23]. For our study, research demonstrates that citizens' actions are most strongly predicted when emergency communications are received from neighborhood and community member sources rather than sources detached from the local setting [24], presenting an important challenge to the bureaucratic and top-down mode of information dissemination. Communities are inherently different and need targeted information, tailored to the disaster type and community composition. In addition, information needs to be two-way, so that those at risk in a disaster or crisis can provide and receive specific advice about their household and what action to take to protect themselves and their property [24].

To address the foregoing information challenges there has been a push towards digital technology such as social media (but also mobile/web-based systems) for transmitting fast and clear information [25, 26]. This has been critical for both disseminating information (e.g. coping strategies, precautionary advice) and collecting information from at-risk populations. There is evidence of social media being linked to protective action against a hazard [1] and allowing segments of the community that have not participated in traditional ways to connect with government agencies and EROs [9]. Importantly though, this research recognizes that the volume of social media data has introduced challenges around reliability and veracity of information, thus, diminishing peoples' ability to find the information needed to organize relief efforts, find help and potentially save lives [27, 28]. Some research suggests a mismatch between use of social media by response organizations and the expectations for their use held by the general public [1]. At the organizational level this can be explained by deficiencies in strategy and training, uncertainty, and lack of resources to make meaningful use of social media or make sense of the data [28].

2.3 A focus on vulnerable persons

The foregoing sub-sections point to an increasing diversity of actors and a growing role for digital technology in disaster contexts, while at the same time acknowledging information challenges. Typically, academic research that addresses these issues treats individuals and communities as homogenous [29]. However, post-disaster reports across the globe—e.g. from Australian bushfires and

earthquake and tsunami in Japan [12, 13]—have highlighted the disproportionate number of fatalities amongst groups defined as 'vulnerable'. As noted, this category typically encompasses older, disabled, lower socio-economic and marginalized persons. There are also meta-categories such as lack of access to resources or services, isolation, and temporal dimensions to vulnerability. Vulnerable persons suffer from disasters for a number of reasons, including lack of mitigating actions and uninformed decision making [30]. This is not limited to the immediate threat of a disaster itself. For example, the IFRC [20, 30] found that certain groups such as the elderly, disabled, widowed, and tenant women endure multiple discriminations when attempting to access information, relief assistance, and reconstruction subsidies. Individuals within these groups often have different information behaviors, technology availability, or digital literacy and practices, and rely heavily on (offline) social networks [11, 24].

In terms of institutional responses, despite their increased risk, these groups are often given low priority and little attention before, during, and after disasters, with few government agencies, NGOs or guides dedicated specifically to their unique needs [30]. Governments and aid agencies often assume individuals are looked after by their community or family [23] and that mass distribution of information will reach them. However, this is not necessarily the case and information services such as mobile messaging and the Internet may also be disrupted by the disaster. Consequently, vulnerable individuals are often left to cope alone [20], remain invisible and marginalized, and find it hard to obtain humanitarian relief, information, and economic and social support [20, 30].

3. Research study

We undertook a case study examining a range of actors involved in providing information and/or responding to disasters and crisis in a State of Australia. The case is interesting because the State implemented the 'One Source, One Message' paradigm of information dissemination to ensure consistent, trusted information and communication. The case allows us to pay attention to tensions between actors, information flows both upstream and downstream, and the translation processes that occur.

We followed an interpretive case study approach, which is well-suited to illuminating the use of information systems in organizations [31]. We interviewed 43 stakeholders across 28 organizations (see Table 1). Drawing on multiple organizations allowed us to explore the case from diverse and multilayered perspectives [32]. Our sampling approach can be defined as purposive as we identified actors, predominantly through professional networks and online searches; this was then complemented by a snowballing technique. A semi-structured interview schedule was followed which focused on the organization's role, how it shares information, the tools it uses (with a focus on social media), how it reaches out to specific communities, and its inter-organizational information sharing approaches and challenges[3]. While most studies are framed around a specific incident such as a bushfire, hurricane or flood [18, 19], interviewees in our study were free to reflect on a range of incidents [33]. Interviewees reflected on several disasters that they vividly recollected, predominantly bushfires, floods and heatwaves. Importantly, the reflections accounted for incidents over time, covering multiple instances rather than a single snapshot of the study phenomena. They referred to a range of vulnerable groups such as older persons, socially/geographically isolated persons, and refugee/recent migrant communities, as well as transient persons such as tourists (an at-risk group during bushfires). Interviews were conducted face-to-face or over the phone. Most interviews were audio-recorded with the permission of the interviewee, or comprehensive notes were taken, allowing the discussion to be reconstructed immediately after the interview.

Table 1. Data collection

	Org.	Example org.	No.*
Upstream → downstream	*Gov. agencies*	Central organizing agency; Fire and Emergency Services Authority	4/10
	EROs	Police; Fire brigade	3/8
	Local gov.	Local councils	5/9
	Comm. groups, NGOs	International NGO; local community groups; auxiliary response groups	14/14
	Platform org.	Sharing economy firm, not-for-profit	2/2

**Number of organizations / interviewees*

In addition to the interviews, study participants were forthcoming with numerous additional materials regarding their work. Illustrative examples include both an NGO and local government disaster guide and preparation manual, and ERO and government strategic reports. These materials contributed to our understanding of organizational strategies and procedures.

[3] The interview schedule is accessible at https://bit.ly/2Pv1mBU

Data collection and analysis were conducted simultaneously so understanding could emerge from the theoretical concepts and empirical content. The interviews were transcribed verbatim and entered into NVivo qualitative software for analysis, as were notes and memos. In total, 620 pages of qualitative data were analyzed. Saturation point was reached when no new themes emerged from the data.

Our coding sequence followed the logic of open coding, axial coding, and selective coding, and the constant comparative method [34]. To ensure a systematic and reliable coding process, two authors analyzed each transcript; after analysis of each transcript we compared and contrasted codes to negotiate a consolidated yet evolving code book. Through multiple rounds of axial coding we identified relationships among the open codes. As our analysis developed, we applied selective coding to address our research question, focusing more on conceptual abstraction (or the 'story-line') based on our insights into the research [34]. This allowed us to manage the volume of data and constantly organize codes into a coherent structure. In the analysis presented here we rely heavily on interview quotes and examples as interpretative evidence; building an analytical and explanatory narrative account.

4. Findings

Our findings focus on two key aspects relevant to our research question: the links and interdependencies between the organizations, with a focus on information and the role of social media; and the dominant strategies and translation processes that unfold between the actors. Our sample comprised a diverse set of organizations. Table 2, based on the analysis of interviews and organizational documents summarizes how they address the informational needs of vulnerable persons, the role of social media in the work of that organization, the specificity of information provided, and the directional information flow. While the table presents the activities of actors as silos, there existed clear interdependencies amongst them. Notably, a mandated Joint Standard Operating Procedure guided hierarchical flow of information from the central government actor to EROs, local governments and NGOs, which filtered through to community groups.

> *it's about having, you know, one place for people to look at for all emergencies…And then it's about actually having a suite of tools for them to actually access this information…So, it's actually about having the suite of information or having the one place to have incidents published, the suite of information to actually get it out there, yes, which I know sounds really simplistic* (GOV2).

This hierarchy extended to one of the platform-based actors that had formal strategies in place with government actors to provide disaster related information to customers. While pointing to a top-down information hierarchy, more dynamic and two-way information flows mediated by social media [1] also played a significant role.

> *social media has to be a part of the communication suite that we use. So, yes, it's come a long way. And also from a community perspective, you know, there's an expectation that they can contact us and that we will speak to them* (ERO2).

Table 2 (column 4) indicates that the specificity and contextualization of information increased amongst the downstream actors, as they followed a more organic approach to understanding the complexities of community response and needs of vulnerable persons: '*shining a light in dark places that government isn't really interested in*' (NGO1).

Upstream actors—the EROs and government agencies—followed multi-channel approaches to information sharing, as mandated in their operating procedures. In terms of social media, this included Facebook, Twitter and Instagram (with some exploration of Chinese-focused social media like WeChat), and was complemented by digital technology including organizational websites, SMS and mobile apps. Platform-based actors relied on their platforms for engaging with vulnerable persons. One used its platform to match vulnerable persons with people that could help. The other distributed top-down information to its users and pointed them to government sources, following the 'one source, one message' paradigm: '*messaging is sent as soon as an incident is confirmed and sufficient safety information is being updated from local authorities*' (PLA1). It also shares this information via Twitter and Facebook.

> *We typically do not provide such warnings (tailored to specific vulnerable groups), our messaging includes links to local officials where guests and hosts can receive latest updates on the situation as it unfolds* (PLA1)

NGOs/community organizations predominantly relied on Facebook as their information-sharing medium and space for networking and connecting. For some locally focused community groups Facebook was the glue that held them together and provided an alternative to traditional top-down information [18].

Table 2. Focus on vulnerable, social media and information flows

Org.	Focus on vulnerable communities	How social media is used	Specificity of information and information flow
Gov. agencies	Provide information to wider community; some provision to engage the vulnerable specifically.	Provide guidance and information to community; engage with the wider community; gather intelligence.	Broad scope, incident specific information. Emphasis of flow from agency to community. Some flow from community to agencies.
EROs	Provide information to wider community; some provision to engage the vulnerable specifically.	Provide guidance and information to community; engage with the wider community; gather intelligence.	Broad scope, incident specific information. Emphasis of flow from government to ERO to community. Some flow from community to EROs.
Local gov.	Identify the vulnerable and develop suitable communication/support activities.	Provide guidance and information to community; engage with the wider community; gather intelligence.	District- or community-centric. Information flow largely from local government to community. Some flow from community to local government.
Comm. groups, NGOs	Utilize local networks and connections to identify and support community member needs, including vulnerable persons.	A forum for sharing of information/networking; localized intelligence; 'go to' source of information.	Local community; combine information from official sources with localized content; sharing local knowledge/information; greater multi-directional information flow.
Platform org.	Provide information to wider community; connect persons that need help.	Provide guidance and information to customers.	Customer-centric; use largely government and ERO content to assist customers; or not providing guidance or information at all.

Having sketched out the activities and interdependencies of organizations we turn to examining the strategies and translation processes that take place across the organizations in engaging with vulnerable groups. Figure 1 (Appendix 1) presents a process chart of the information flows as derived from the qualitative data. Similar to Adrot and Figueiredo [16] it illustrates the intensity of ties, with a focus on information. Upstream actors were acutely aware of the risk to vulnerable persons and had formulated strategies for engaging them.

> *Many of those messages are targeted directly to vulnerable people. So, people with a disability, people caring for children, or elderly people* (GOV3)

For this reason, there are strong links between government agencies and NGOs that work directly with vulnerable persons. The NGOs have direct access to these groups and undertake community engagement—*'their resource (a planning guide) for engaging with more vulnerable members of the community around, so their social preparedness, you know, the need to know your neighbours'* (GOV3).

As noted in Figure 1, upstream actors predominantly push out information (as indicated by the thickness of the lines; the thinner lines indicate the lesser information flows from the downstream actors to the government agencies/EROs). Upstream actors explained that their internal analysis of how their social media content is used shows 'intermediaries' or 'information brokers' [35] are often an important part of the network as they act as information intermediaries for vulnerable persons. Therefore, it is a matter of using social media to '*tie into local trusted networks*' (GOV4) and understanding where vulnerable persons are connected to the community.

> *There will be people who have no connection, I absolutely accept that, but there will be people who are connected into something, and it's just understanding what that something is* (GOV2)

It may also involve social media campaigns that target persons who act as information brokers. For example:

> *for the heat campaign, we target middle aged women, because they are more likely to look after young children, as well their elderly parents, who are both vulnerable people in heat* (GOV2)

This builds on the realization that social media content is often shared. As well as direct communication, it is used to arm individuals with

information that can be relayed (offline) to vulnerable persons: 'a *warning post would actually be just people notifying each other. And then you'll see comments, oh, 'tell Mum', you know'* (LGOV2).

By doing so, upstream actors provide a clear and consistent message, while delegating to citizens the roles of contextualizing, translating and sharing for vulnerable persons. This is critical because, in addition to the consistent message, it also helps address tensions in framing multiple messages to different groups and getting individuals to act on them.

> *[people] will certainly not align themselves to messages that appear to be directed towards people with any level of vulnerability or frailty.* (ERO2)

As noted in Figure 1, downstream actors relied on top-down information but adopted different strategies in using social media to reach out to their constituents, either directly or through co-creation of more contextualized information. Three overlapping strategies are identified.

Strategy 1–Contextualizing and sensemaking: As a disaster or crisis unfolds, social media spaces act as a place for community members to post information about environmental signals (e.g. smoke), post photos of flooded roads, inaccessible areas or alerts via broadcast media, and ask for verification. Thus, social media is used for resilience building, self-coordination and providing help [1]. In addition, local community groups often have someone involved in the fire service auxiliary that either acts as an information gateway between upstream and downstream actors or can help with making sense of environmental signals.

> *There'll be a Bureau of Meteorology extreme weather warning, we'll (community group) put that up (on the social media page) and then that usually starts a conversation with the community. Then the community will post back on the site, images and the community will respond to those messages. So, we would be posting the official messages but it sort of takes-off from there with the community.* (COM13)

The sharing of information (as in the quote above) acts as a catalyst for offline and online information sharing action, whereby information '*reverberates*' (COM8) and the process of translating and making sense for vulnerable persons takes place. This includes posts about how close a bushfire is to a local area, where to find places of refuge, or needing help. It may involve tagging someone to act or pass on a warning if, for instance, a bushfire is in the vicinity of someone known to be vulnerable. Significantly, it may trigger offline chains of notification whereby one person checks in on another, and so on. This was noted as particularly significant for refugees/newly arrived migrants, elderly, and disabled persons.

Strategy 2–Community resilience: This strategy considers that vulnerable persons may not be reachable through social media. It focuses on using social media as a means of making a local community aware of at-risk groups, with messages used to encourage action and engagement with vulnerable persons. This is similar to the approach of upstream actors, which involves reaching out to intermediaries and informing the community of at-risk groups: '*look out for vulnerable, older people in the community*' (COM2); '*educating people about disadvantage and about victims in our community'* (COM4). Within this strategy, action directed at vulnerable persons is often undertaken offline: '*Social media for us is more about a broad-brush approach. Like more broad community...I think for the vulnerable groups we work with, we would use other means'* (COM7). This supports the view that social media is a complementary rather than substitute tool.

Strategy 3–Reaffirming top-down messages: Downstream actors also refrain from providing tailored information. That is, while they allow their social media spaces to be used as places for information sharing, they do not engage in any interpretation; instead they prefer to point to top-down information sources—'*don't come to us for info, we're not going to give it to you*' (COM5). Likewise, a private platform-based actor reported that they only provide links to official sources but will provide follow-up assistance accommodating the language preference of customers by phone, social media, or email. This is particularly relevant to tourists. One international NGO managed its social media strategy at a national level: '*it's vanilla…it's not dynamic, it's not moving, it's not live, it's not real, which is the actual premise of those platforms*' (NGO1). This approach was adopted as previously the NGO had '*a lot of messaging that was conflicting—potentially*' (NGO1). However, it used its platform to re-affirm the top-down message to vulnerable groups that may be out of the periphery of upstream actors:

> *we're pretty active about getting messages out there to say, you know, look after yourself, prepare and have a think about, and just grabbing the information from the emergency services…pushing that out…using our trusted brand to enhance that* (NGO1).

While the quote demonstrates a strategy of re-affirming, the NGO relied on being part of community groups on social media via its volunteers. A challenge it faced is that its volunteers are not 'digital volunteers' [36]: '*the volunteers are not that type of cohort...they're not Twitter users*' (NGO1). The NGO was aware of the need for specific information and is developing strategies to take generic information and '*spice it up a little bit with some real-time information*' (NGO1).

5. Discussion and conclusion

Within the crisis informatics literature, how to mobilize a timely response to save lives, minimize damage and losses is a key concern. We have contributed to this literature by focusing on the interplay between different actors [4, 6, 8] and the role of social media in delivering information to vulnerable persons. We demonstrate how upstream actors followed a top-down approach and used social media to reach out to information brokers who may then engage with vulnerable persons. Downstream actors adopted three overlapping strategies: Strategies 1 and 2 focused on either contextualizing information or reaching out to vulnerable persons through information brokers, while Strategy 3 focused on reaffirming top-down messages for hard-to-reach groups (with local action undertaken offline). The notion of information brokers has been noted in the crisis informatics literature [35]; we build on this by showing that they are not only virtual actors but are also a trusted intermediary for vulnerable persons.

As noted in Figure 1, downstream actors rely on information from both upstream actors and their constituents—meaning that information is spread across time, space and perspectives. In addition, social media is enacted in different ways at different levels [18]. Information is shared, tailored and contextualized in an organic way. We see this as a process of negotiated meaning, where different parts of a network of actors distribute, share, interpret and enact information in different and continuously evolving ways [37] as a means to deal with ambiguity. (We also noted community groups that refrained from using social media for this purpose). Therefore, we add to the literature that sees disaster and crisis response as a complex system composed of adapting and self-organizing actors [7]. In our case, we see adaptation taking place to meet the needs of vulnerable persons. This links to the notion of self-reliant communities with the skills, knowledge and ability to minimize the impacts of hazards.

As organizations are still experimenting with different ways to provide information to citizens, particularly vulnerable persons, we identify several key tensions. The first is between the bureaucratic model of top-down and generic information and the demand for information that is location-specific and contextualized to individuals' needs. The second lies in the ongoing difficulty around providing warnings that people will act on [21]. With vulnerable groups, a challenge for upstream actors is the balance between consistent/clear information and targeted/ contextualized information—whilst accounting for bias against alignment with vulnerability. A third tension emerges with the growing convergence of actors and parallel increase in complexity of the translation process. In these circumstances, divergent interpretations may take place [18] and may result in outcomes and behavior that is difficult to predict [7]. There is a need to better explain how platform-based actors fit in this information landscape. While the literature has examined platform-based actors, these have been predominantly managed by traditional actors e.g. the Red Cross [6]. We have shown how non-traditional actors are leveraging their platforms and subsequent connections to provide information.

In our study, vulnerable persons were only given a voice through the organizational actors. Vulnerable groups face an enduring problem of low participation due in part to individual differences in the desire to be part of a group, low levels of risk awareness, and low social capital. Further, it merits mentioning that many vulnerable groups do not consistently use digital media and complementary research is needed to examine the broader range of their information practices; thus, the need to trace translation processes and flow of second-hand information from social media. Future research might usefully:

(i) Expand studies to account for the co-creation of information between vulnerable persons and the range of organizational actors.
(ii) Focus on specific groups to identify commonalities and differences across the category of vulnerability.
(iii) Examine the interactions and content in online communities used by vulnerable groups, to uncover appropriate ways to meet the information needs of vulnerable groups.
(iv) Investigate how upstream and downstream actors navigate the transition from generic to specific information, considering the role of social media and information practices in this process.
(v) Study the convergence of actors [6, 14] and increasing role of technology [8] for addressing the concerns of vulnerable persons.

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Appendix 1

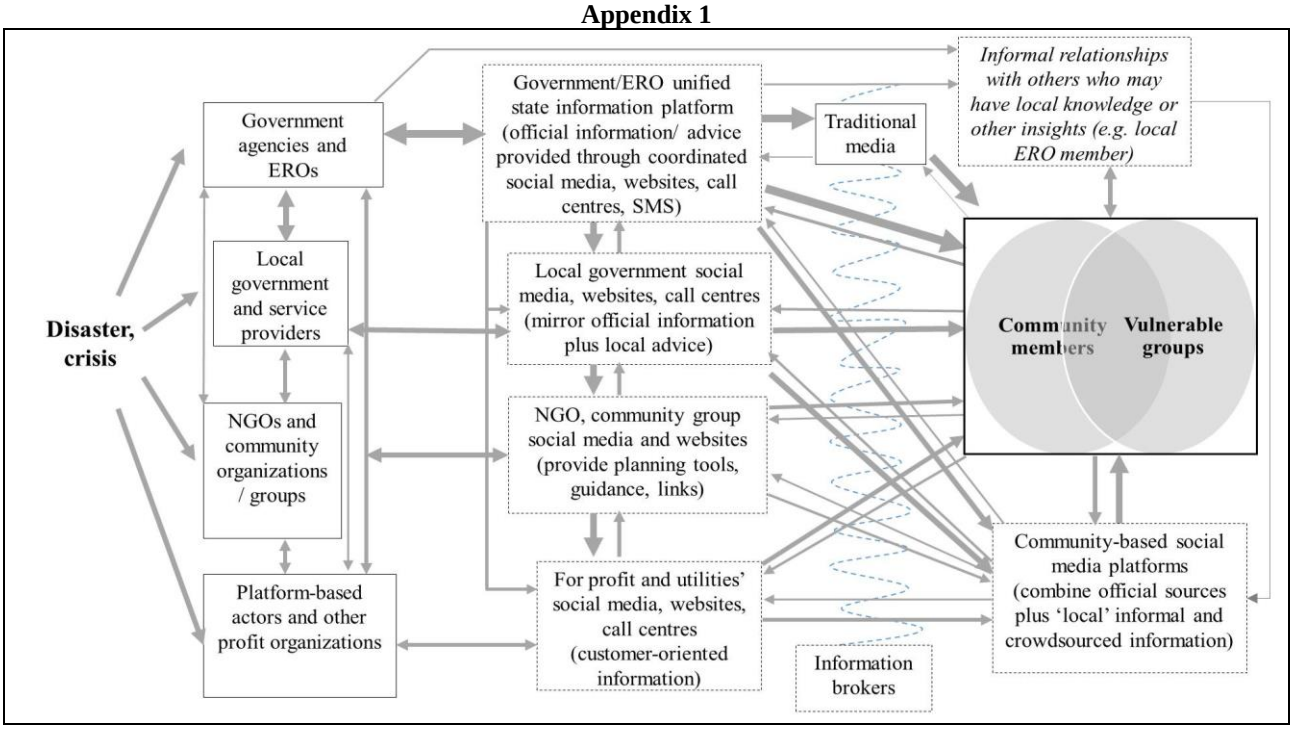

Figure 1. Information flows between actors (*Note: broken lines emphasize areas of more prominent social media use; the wavy blue line represents the role of information brokers*).